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Description

PRODUCTIVE PROCESS FOR MANUFACTURING AN ALGAL SPECIES-BASED ORGANIC COMPLEMENT FOR VEGETAL FERTILIZATION

BACKGROUND OF INVENTION

[0001] The increased demand for organic fertilizers in developed countries and the current tendency to its sustainability regarding the industrial wastes management, which minimizes the environmental impacts, are situations considered as relevant. In this context, it is envisaged to provoke a positive environmental impact generating a productive alternative directed to the use of low commercial value algae for the production of a complement for organic fertilization.

SUMMARY OF INVENTION

[0002] The features of this organic growth complement are based on function of the marine algae contributions, which com-

prise a wide range of mineral elements, aminoacids, vitamins and auxin- and cytokinin-type phytohormones.

[0003] The resulting product contains these elements in an active form, therefore, a higher plant production and/or better yielding can be obtained when it is supplemented to plant crops with a basal fertilization suitable for the vegetal type. Furthermore, this product fulfills or meets the following organic standards: EU N°2092/1; USDA/NOP Final rule (USA), and the JAS Japanese Agricultural standard for Organic Agricultural Products (Japan).

[0004] This organic complement for basal fertilization allows better seed germination, an increase in root development, a faster and more uniform plant stabilisation, an increase in the nutrients absorption, a more efficient nutrients exploitation, tissue composition improvements, higher resistance to frost, higher resistance to drought and a faster recovery, higher resistance to diseases and plagues (by fungi and insects), and longer shelf-life.

[0005] The term "basal fertilization"is understood as the soil fertilization necessary to be applied to a soil once checked, the soil being in need of macronutrients (nitrogen, phosphorus and potassium) and micronutrients (molybdenum, magnesium, boron, etc.) considering the vegetal type to

be growth.

[0006] Applying this product as a fertilization complement achieves a maximum effect within a monitored fertilization program, with a constant soil analysis. Using this product, soils do not require (as usually) an over-dosage, since a minimal but exact fertilizer contribution is enough in order to achieve optimal yields.

[0007] Furthermore, it is important to note that the obtained "organic product"as prepared from raw organic matter consisting of "organic" sources, through the process herein described, allows to provide a fertilizer complement for plant growing that is certifiable for use for organically grown food crops.

Brief Description of Drawings

[0008] Figure 1 shows a flow chart of a typical process for making the organic fertilizer complement.

[0009] Figure 2 shows a mass balance and process condition flow chart for the manufacture of an organic fertilizer complement embodiment of the invention.

[0010] Figure 3 shows a typical processing equipment system for producing the organic complement.

Detailed Description

[0011] The present invention provides an organic fertilizer complement, its method of making the fertilizer complement. The organic fertilizer complement is manufactured from green algae (*Ulva rigida*, hereinafter "*ulva*") and brownish algae (*Macrocystis pyrifera*, hereinafter "*macrocystis*"). The organic product provides features of a vegetal growth stimulator for plants. The product provides improved absorption efficiency of the nutrients supplied by the fertilizers, guaranteeing an optimal growth for the plant species, and achieving higher production in a short period of time. the product is biodegradable and beneficial for soils.

[0012] The process for obtaining the fertilizer complement from the *ulva* and *macrocystis* typically includes the steps of washing, grinding, acid and alkaline digestion, filtering and packaging. Typical other raw materials are inorganic acids and salts, such as hydrochloric and phosphoric acid, and potassium carbonate.

[0013] Figure 1 shows a flow chart of the steps of a process for making the organic fertilizer complement. Figure 2 shows a flow chart showing the mass balance and process conditions for an embodiment of the process of the invention. Figure 3 shows a typical process equipment system used to process the fertilizer complement.

[0014] The typical production process for the manufacture of the organic fertilizer complement for fertilization is described as follows:Raw Materials Reception: Fresh, whole *Macrocystis*, previously washed with salted water in order to remove sand and foreign organisms, is received. *Ulva* is received, dried and minced. Both raw materials must be in good conditions and without malodors or other strange odors. Any equipment items used in the description below are shown in parenthesis and referenced in Figure 3.

[0015] Grinding: The dried *Ulva* is ground to about 0.2 mm in a blade mill (12) for achieving good homogenization when later admixed with the *Macrocystis* during the alkaline digestion step, described below.

[0016] Weighing: The fresh alga *Macrocystis* and the ground and dried alga *Ulva* are weight into portions at a weight ratio of 1:1 on a fresh algae base. The weight ratio can vary up to 10:1 if dried *Ulva* is used.

[0017] Washing: The fresh alga *Macrocystis* is placed in the perforated basket (16), and immersed into a conical vessel (1) containing cold tap water. This operation is repeated until it is established that the *Macrocystis* is clean and that the salts have been removed satisfactorily. A checking of the salt removal can typically be carried out by pouring about

20 ml of washing liquid in a tube and adding 3 drops of $AgNO_3$. If a white precipitate forms, then excessive salts are still present. This operation and the checking are carried out until the precipitate formed is minimal. Alternative means of checking can include a batch or continuous analysis of the electric conductivity of the washing liquid using instrumentation that are well known to those skilled in the art. For accelerating the washing process at the time of draining the vessel, water can be sprayed.

[0018] Mincing: The washed alga *Macrocystis* is then minced in a turbine mill (13) until a typical particle size of about 1 cm diameter is achieved. The minced algae is subsequently placed in a perforated basket (16). This step has as a first objective to facilitate the handling of the alga during the process, and as a second objective to achieve a particle size which allows the subsequent reagents to uniformly penetrate within the alga, thus achieving more homogeneous reactions and better control of the chemical treatment.

[0019] Acid Treatment: The perforated basket with the minced *Macrocystis* is immersed in the jacketed vessel (2) containing, per 1 Kg of *Macrocystis,* 2 parts by weight of water and 25 ml of 0.2 N HCl, for 30-40 minutes at ±50°C under

constant stirring (mixer 17). This treatment removes the mineral salts and the excess soluble organic material which was not removed in the previous washing step, as well as the sediments and organisms associated with the raw algae. An ionic exchange chemical reaction is carried out, principally between the calcium ions and other divalent ions as magnesium and strontium contained in the algae as the corresponding divalent metal alginate, thus producing alginic acid (HAlg), which is removed from the algae into the acid liquid.

[0020] The chemical reaction is as follows: $Ca(Alg)_2 + 2HCl \rightarrow 2HAlg + CaCl_2$

[0021] Draining: To carry out the residual liquid and solid separation, the perforated basket (16) is raised out of the jacketed vessel (2), leaving the acidic liquid to drain by gravity.

[0022] Washing: The resulting drained solids are washed with cold water, such as by spraying water through a hose into the basket containing the algae, for complete removal of the alginic acid.

[0023] Grinding: The washed algae *Macrocystis* is ground in the turbine mill (13) having a sieve that has 0.4 cm holes, for mechanically reducing the algal particles to assist in their

dissolution during the subsequent digestion step; thus, the smaller the particle size, the more effective shall be the reaction.

[0024] Digestion: An alkalinizing agent, potassium carbonate salt (K_2CO_3), is solubilized in hot water in a jacketed vessel (3). The proportions of the algae and salt are, per 2 liters of water: 1 Kg of ground *Macrocystis* and 10 g of K_2CO_3. The perforated basket (16) of freshly-ground *Macrocystis* is immersed in a jacketed vessel (3). The dry, ground algae *Ulva* is added and mixed. The solution pH is controlled (near to pH 10), at a temperature of 65 ±5°C, for a time of 2 hr, under constant stirring (mixer 17), for obtaining a high extraction yield of potassium alginate. In this step, a neutralization reaction occurs between the alginic acid comprised in the algal particles and the potassium alkali, which produces potassium alginate in aqueous solution.

[0025] The reaction carried out is as follows:$HAlg + K_2CO_3 \rightarrow KAlg + CO_2 + H_2O$

[0026] This reaction is important since to a large extent the yield and quality of the final product depends on the control of the physical-chemical parameters that are involved therein.

[0027] pH measurement: Immediately after the digestion step is

finished, the pH is reduced with an acid agent, phosphoric acid (H_3PO_4) from pH of about 9-5-10 to pH 4.5 - 6.2 at a temperature of about 50°C, for achieving better stabilisation of the final product.

[0028] Filtering: Using a plate and frame filter-press (7) using a cellulose media as a filtering media. An objective of the filtration is to clarify the pH-adjusted extract solution by removing the non-soluble particles that remain after the digestion.

[0029] Storage: Using fiberglass vats (8, 9, 10 and 11) the fertilizer solution product is allowed to cool for approximately between 1 to 2 days. Storage includes avoiding any kind of contamination, damage or deterioration of the product, while it is not dispatched, and controlling its environmental conditions: temperature and exposure to light.

[0030] Packing: The liquid fertilizer complement product is packaged into plastic containers for its subsequent transport and distribution. It is necessary to note the importance of the packaging as an aspect of the quality in the product delivery, since it is the main way of maintaining quality in the distributed products.

[0031] The fertilizer complement can further comprise mineral elements, aminoacids, vitamins and auxin- and cytokinin-

type phytohormones, based on the marine algae *Ulva* and *Macrocystis* contributions.

[0032] The fertilizer complement according to the present invention comprises algal particles as well as some inorganic compounds as indicated in Table 1, wherein are showed the percentages of these components on 100 L of the final product.

[0033] The obtained product, prepared from "organic" sources and the process above described, is able to provide plant growing certifiable for for being used in organically grown food crops. Thus the fertilizer complement can be added to plants growing media in order to provide a growth stimulator source which complies with "organic" standards for organically grown food.

[0034] As stated above, it is highly desirable to obtain a product which meets with the requirements established in the organic standards: EU N°2092/1; USDA/NOP Final rule (USA), and the JAS Japanese Agricultural standard for Organic Agricultural Products (Japan).

[0035] Thus, as an organic product for being applied to organically grown food, it is necessary to guarantee that the obtained final product is free of toxic elements, specifically heavy metals, which are hazardous for living beings. Table

2 shows the level of arsenic, mercury and cadmium contained in the final product according to the present invention, wherein said levels have been measured by atomic absorption spectroscopy.

[0036] According to the mentioned standards, the heavy metals content, specifically As, Hg, and Cd, must not be higher than 5%. The product of the instant invention fulfills satisfactorily these requirements.

[0037]

TABLE 1

Fertilizer Complement Ingredients	%
Macrocystis and *Ulva algal* particles	56
Water hydrochloric acid	43 <0.01
potassium carbonate	0.6
phosphoric acid	0.3
potassium sorbate	0.1

[0038]

TABLE 2 : HEAVY METALS COMPOSITION FOR THE ORGANIC COMPLEMENT FERTILIZER			
	Arsenic*	Mercury*	Cadmium*
Maximun allowed by the EEC	10 (mg/kg)	1 (mg/kg)	1 (mg/kg)
Ulva	1.03	0.01	0.91
Macrocystis	0.24	0.00	0.24
Final product	0.05	0.00	0.02
* Atomic absorption spectroscopy, mean value of duplicated samples			

[0039] Example:In a preferred embodiment of the invention, a vessel is provided with water (100 L) at a temperature of about 40-60°C and 1.25 liters of 0.2 N HCl. 50 kg of minced *Macrocystis* is added and stirred during 30-40 minutes. The residual liquid is removed and the solid is ground and then incorporated into a second vessel with water (200 liters), potassium carbonate (1 kg) and minced *Ulva* (50 kg) for 2 to 2-1/2 hours at a temperature between 60-70°C. After filtering, the pH is lowered to between 4.5 - 6.2 with phosphoric acid, to produce the resulting liquid fertilizer complement.